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In re Patent Application of:  
**TOWNES**

Serial No.: 10/720,333  
Filed: 11/25/03

Group: 3745  
Examiner: WIEHE, Nathaniel Edward

Title: BLADE COOLING

**PRIORITY CLAIM SUBMISSION AND CERTIFIED COPY**

Date: April 24, 2006

Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

Sir:

It is respectfully requested that under the provisions of 35 USC 119/365, this application be given the benefit of the foreign filing date of the following, a certified copy of which is attached hereto:

Application No.  
**0227745.7**

Country of Origin  
**Great Britain**

Filed  
**11/28/02**

Respectfully submitted,

  
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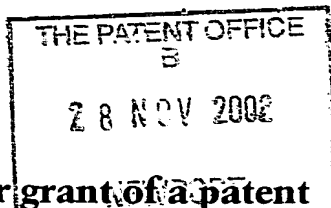
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Dated 2 October 2003

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P01/7700 0.00-0227745.7

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1. Your reference

DY3050

2. Patent application number

(The Patent Office will fill in this part)

0227745.7

28 NOV 2002

3. Full name, address and postcode of the or of each applicant (underline all surnames)

ROLLS-ROYCE PLC  
65 BUCKINGHAM GATE  
LONDON  
SW1E 6AT

Patents ADP number (if you know it)

397000

If the applicant is a corporate body, give the country/state of its incorporation

ENGLAND

4. Title of the invention

BLADE COOLING

5. Name of your agent (if you have one)

M A GUNN

"Address for service" in the United Kingdom to which all correspondence should be sent (including the postcode)

ROLLS-ROYCE plc  
PATENTS DEPARTMENT  
PO BOX 31  
DERBY  
DE24 8BJ

Patents ADP number (if you know it)

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6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and (if you know it) the or each application number

Country

Priority application number  
(if you know it)

Date of filing  
(day / month / year)

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application

Date of filing  
(day / month / year)

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? (Answer 'Yes' if:

YES

- a) any applicant named in part 3 is not an inventor, or
  - b) there is an inventor who is not named as an applicant, or
  - c) any named applicant is a corporate body.
- See note (d))

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Continuation sheets of this form

Description

9

Claim(s)

2

Abstract

1

Drawing(s)

2

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Priority documents

Translations of priority documents

Statement of inventorship and right to grant of a patent (Patents Form 7/77)

2

Request for preliminary examination and search (Patents Form 9/77)

1

Request for substantive examination (Patents Form 10/77)

1

Any other documents (please specify)

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11.

I/We request the grant of a patent on the basis of this application.

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Date

27.11.2002

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ROLLS-ROYCE plc

CASE NO: DY3050

RR TITLE: [REDACTED]

APPLICATION NO:

DATED: 28 NOVEMBER 2002

FIRST APPLICATION

DRAFTED BY: S&P FOR Gnn

PATENTS ACT 1977

SPECIFICATION

BLADE COOLING

THE BUREAU OF THE ARMY (GPTO)



Blade Cooling

The present invention relates to blade cooling and  
 5 more particularly to arrangements for feeding coolant from  
 a mounting disk or hub to turbine blades in a jet engine.

Cooling of turbine blades in a jet engine is important  
 in order to maintain structural integrity whilst the blades  
 operate at high temperatures approaching if not exceeding  
 10 the melting point of the materials from which the blades  
 are made. Turbine blades generally include a coolant  
 passage network within their structure within which coolant  
 air circulates in order to cool the blade. Such coolant  
 air must be coupled to the coolant passage network within  
 15 the blade. Generally, a central coolant supply system is  
 coupled to the blade coolant passage network.  
 Traditionally, a specific connecting hole or passage has  
 been made in the mounting hub or disk to which the turbine  
 blade is secured such that an opening in that blade is  
 20 substantially aligned with the feed hole or passage in the  
 mounting disk in order to present coolant to the blade  
 coolant passage network. Fabrication of such feed holes in  
 the mounting disk as well as reciprocal holes in the root  
 or connecting end of the blade add significantly to  
 25 fabrication costs as well as increased mechanical stress  
 levels and their requirement for thicker material.  
 Alternatively, a space can be created between the root end  
 of the blade and the top surface of the mounting disk or  
 hub. This space acts as a distribution gallery for  
 30 openings connected to a coolant passage network of a blade.  
 These distribution galleries are commonly referred to as a  
 "bucket groove". Essentially, within the distribution  
 gallery there is a positive pressure differential such that  
 coolant air presented at one end is drawn into the openings  
 35 for the coolant passage network of the blade.  
 Unfortunately, coolant flow in a distribution gallery is

turned sharply at least twice as it passes to the coolant passage network of the blade. Such turning can diminish the pressure differential and so flow rate of coolant air into the blade cooling passage network. Clearly, a reduce  
5 flow rate will diminish cooling efficiency and therefore performance.

In accordance with the present invention, there is provided a blade cooling arrangement comprising a coolant gallery formed between a mounting hub and a blade root  
10 including at least one coolant passage opening and a flow deflector associated with that passage opening to deflect in use a coolant flow through the coolant gallery towards that passage opening.

Also in accordance with the present invention there is  
15 provided a flow deflector for a turbine blade, the deflector in use being arranged in a coolant gallery between a mounting hub and a blade root, the deflector associated with a coolant passage opening to deflect coolant flow in the gallery towards the passage opening  
20 whereby such deflection is progressive in order to limit coolant flow pressure loss upon entry through the coolant passage opening.

Preferably, the flow deflector is a curved scoop to progressively deflect the coolant flow towards the passage  
25 opening. Alternatively, the flow deflector is a ramp or wedge to lift coolant flow towards the passage opening to achieve angular flow overlap. Possibly, there is a plurality of flow deflectors to progressively deflect coolant flow towards the passage opening.

30 Possibly, the flow deflector extends upwards from the mounting hub towards the passage opening. Alternatively, the flow deflector extends downwardly from the blade root away from the passage opening.

Possibly, the flow deflector is adjustable dependent  
35 upon temperature or specific requirements. Typically, such adjustment is by variation in material dimensions as a

result of differential expansion and/contraction relative to the mounting cup and/or the blade root. Alternatively, such adjustment may be through mechanical displacement under specific control by a control device.

5 Further in accordance with the present invention there is provided an engine including turbine blades having a blade cooling arrangement or a flow deflector as described above.

Embodiments of the present invention will now be  
10 described by way of example only with reference to the accompanying drawings in which:

Fig. 1 is a schematic cross-section of a first embodiment of the present invention;

Fig. 2 is a schematic cross-section of a second  
15 embodiment of the present invention; and,

Fig. 3 is a cross-section of a flow deflector in the plane AB depicted in Fig. 2.

Referring to Fig. 1 illustrating a first embodiment of a cooling arrangement in accordance with the present  
20 invention. Thus, a mounting hub or disk 11 has a turbine blade 3 secured adjacent to it with a gap or coolant distribution gallery 4 between a mounting or root end 2 of the blade 3 and a top surface 11 of the mounting disk 1. A coolant flow illustrated by broken arrow 5 is drawn into  
25 the gallery 4 from a coolant supply system under a positive pressure differential. The gallery 4 has a passage opening 7 which extends to a passage 8 coupled to a coolant passage network within the blade 3 to provide cooling of that blade 3.

30 In accordance with the present invention a flow deflector 6 located adjacent and around the opening 7 deflects the coolant flow 5 into the passage 8 through the opening 7. The deflector 6 is substantially flat and creates a wedge or ramp to progressively deflect the  
35 coolant flow 5 through the opening 7. In such circumstances, there is less direct or perpendicular

upper surface 11 but then care must be taken with regard to ensuring appropriate location relative to the opening 7 to provide operational association in order to deflect the coolant flow 5 progressively into the passage 8. It will also be understood that separate flow deflector components could be formed as inserts which are appropriately secured within the gallery 4 for correct association with the opening 7 in order to progressively deflect the coolant flow 5 into the passage 8.

10 It is an objective of the flow deflector 6 in accordance with the present invention to provide progressive deflection of the coolant flow 5. Thus, a number of flow deflectors could be utilised in order to act in concert such that there is gentle and progressive  
15 deflection of the coolant flow with limited positive pressure loss upon entry to the passage 8 through the opening 7. It will be understood that air coolant flow through the passage 8 and then into the coolant passage network of the blade 3 is highly determinant of the cooling  
20 efficiency within that blade 3. In such circumstances, a greater degree of cooling may be achieved to allow the blade to operate at higher temperatures and therefore an associated engine to work more efficiently. Alternatively, a lower volume of coolant air may be necessary in order to  
25 provide a required level of cooling for engine operation and such a lower volume of air coolant flow will also improve pro rata engine efficiency.

A number of flow deflectors may be provided to cause deflection. Thus, a primary flow deflector marked by a  
30 dotted line and numeral 10 may be provided in order to create initial coolant flow deflection which is further deflected by the flow deflector 6. However, care should be taken that the impingement by the flow deflector 10 does not create a throttle choking effect by diminishing the  
35 cross-sectional area of the gap between the top of the deflector 10 and the bottom of the blade root end 2. The

scoop for gradual flow deflection through the passage opening 27 into the passage 28.

Typically, as illustrated in Fig. 2 the flow deflector 26 is an integral part of the blade root end 22. The flow deflector 26 may be machined or cast with the blade root end 22 during manufacture. Possibly, a sacrificial ceramic core (shown in broken line 31) may be located within the opening 27 during casting or machining of the flow deflector 26 such that once fabrication is complete the core 31 is removed to leave the flow deflector 26 extending below the opening 27.

Normally, as illustrated in Fig. 2 the flow deflector 26 will extend substantially into contact with the upper surface 32 of the mounting hub or disk 21. Alternatively, the bottom edge of the flow deflector 26 may be spaced from the upper surface 32 to accommodate for expansion and/or contraction of the hub or disk 21 and turbine blade 23 such that overly compressive engagement is avoided and so possible detrimental stressing of the flow deflector 26 is prevented.

It will be understood that the flow deflector 26 as with flow deflector 6 (Fig. 1) could be part of the upper surface 32 of the hub or disk 21 rather than an integral part of the blade root end 22. Alternatively, the flow deflector 26 could be a separate component or insert appropriately secured in association with the opening 27 as required.

Specific choice of the angle of inclination for the wedge or ramp configuration of flow deflector 6 (Fig. 1) or the rate of curvature in the scoop flow deflector 26 will be design choices made dependent upon expected coolant air flow rates, necessary cooling efficiency and other operational factors. As indicated above, by appropriate choice of materials in terms of relative expansion/contraction, these angles of inclination and curvature may be slightly altered through a temperature

range in order to adjust the degree of progressive deflection of the coolant flow into the passage leading to the coolant passage network of a turbine blade.

Fig. 3 illustrates a cross-section of the flow deflector 26 in the plane AB, as can be seen, the scoop or curved wall surface 30 takes the form of a cavity removed from a block cross-section 33. This enables the flow deflector 26 to partially envelope or surround the hole which defines the passage opening 27 so improving coolant air flow 25 deflection into the passage 28 through the opening 27. It will also be understood that the greater dimensions of the block 33 will render the flow deflector 26 more robust potentially in service than the flat flow deflector 6 but will also marginally increase weight for the blade 23 particularly if several flow deflectors are utilised in each blade 23.

The principal function of a flow deflector 6, 26 is to deflect a lateral coolant air flow 5, 25 along the distribution gallery 4, 24 into an opening 7, 27 which is perpendicular to that flow 5, 25. Thus, if the coolant air flow is considered a planar front, the deflector 6, 26 deflects that planar front such that there is greater overlap with the plane of the opening 7, 27 for entry. Ideally, the planar deflection should be in the order of 90° or that required for in-line incidence but normally a balance is struck between the severity of deflection (which effects net positive pressure loss) and the level of flow planar front overlap with the opening 7, 27 (alignment would be an ideal coupling of flow into the opening 7, 27 but normally the deflected flow planar front will be skew of the plane of the opening).

Whilst endeavouring in the foregoing specification to draw attention to those features of the invention believed to be of particular importance it should be understood that the Applicant claims protection in respect of any patentable feature or combination of features hereinbefore

referred to and/or shown in the drawings whether or not particular emphasis has been placed thereon.

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Claims

1. A blade cooling arrangement comprising a coolant  
5 gallery formed between a mounting hub and a blade root including at least one coolant passage opening and a flow deflector associated with that passage opening to deflect in use coolant flow through the coolant gallery towards the passage opening.
- 10 2. A flow deflector arrangement for a turbine blade, the arrangement comprising a flow deflector which in use is arranged in a coolant gallery between a mounting hub and a blade root, the deflector associated with a coolant passage opening to deflect coolant flow in the gallery towards the  
15 passage opening whereby such deflection is progressive in order to limit coolant flow pressure loss upon passage through the coolant passage opening.
3. An arrangement as claimed in claim 1 or claim 2 wherein the flow deflector has a curved surface to  
20 progressively deflect the coolant flow towards the passage opening.
4. An arrangement as claimed in claim 1 or claim 2 wherein the flow deflector is a ramp or wedge to lift  
25 coolant flow towards the passage opening to achieve progressive deflection of the coolant flow towards that passage opening.
5. An arrangement as claimed in any preceding claim wherein there is a plurality of flow deflectors to  
30 progressively deflect coolant flow towards the passage opening.
6. An arrangement as claimed in any preceding claim wherein the flow deflector extends upwardly from the mounting hub towards the passage opening.
7. An arrangement as claimed in any of claims 1 to 5  
35 wherein the flow deflector extends downwardly from the blade root away from the passage opening.



AbstractBlade Cooling

5

In order to couple coolant air flow presented through a coolant gallery 4, 24 through an opening 7, 27 into a passage 8, 28 a flow deflector 6, 26 is provided. The flow deflector 6, 26 progressively deflects the coolant air flow 10 5, 25 through the opening 7, 27 such that there is reduced loss in coolant flow 5, 25 pressure.

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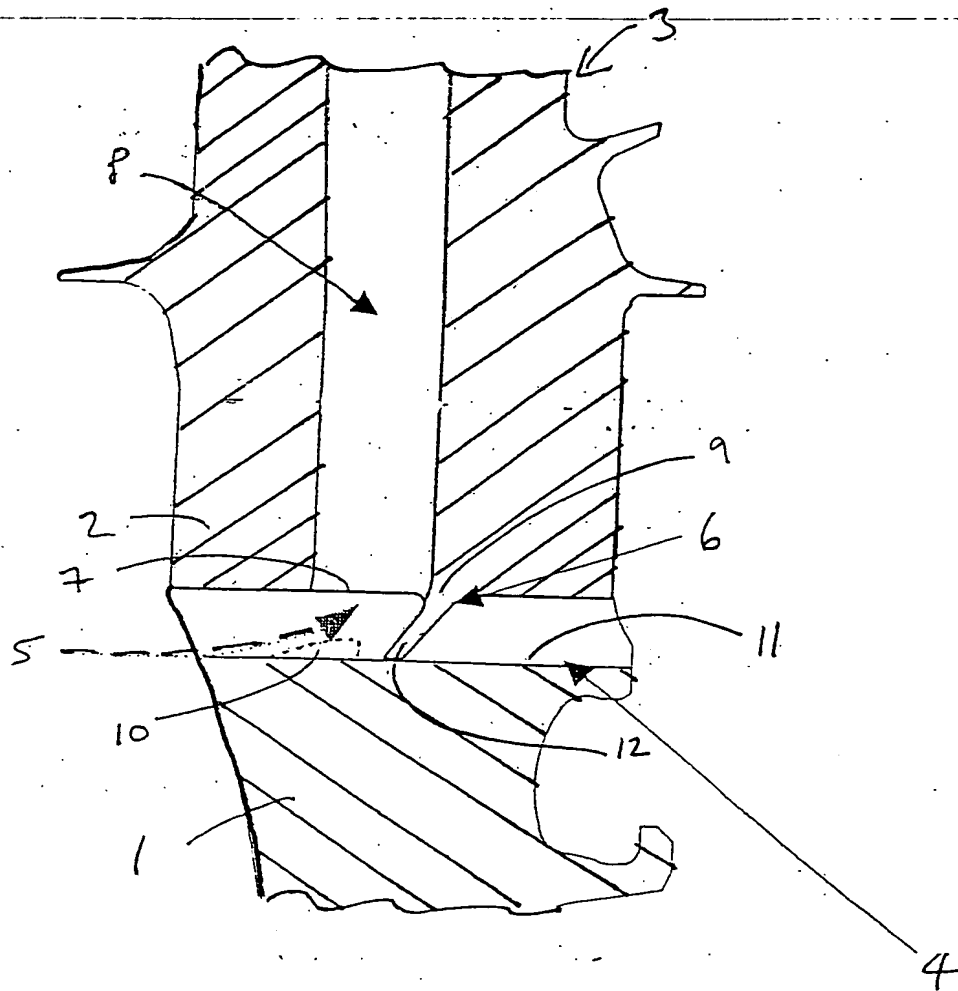


Figure 1

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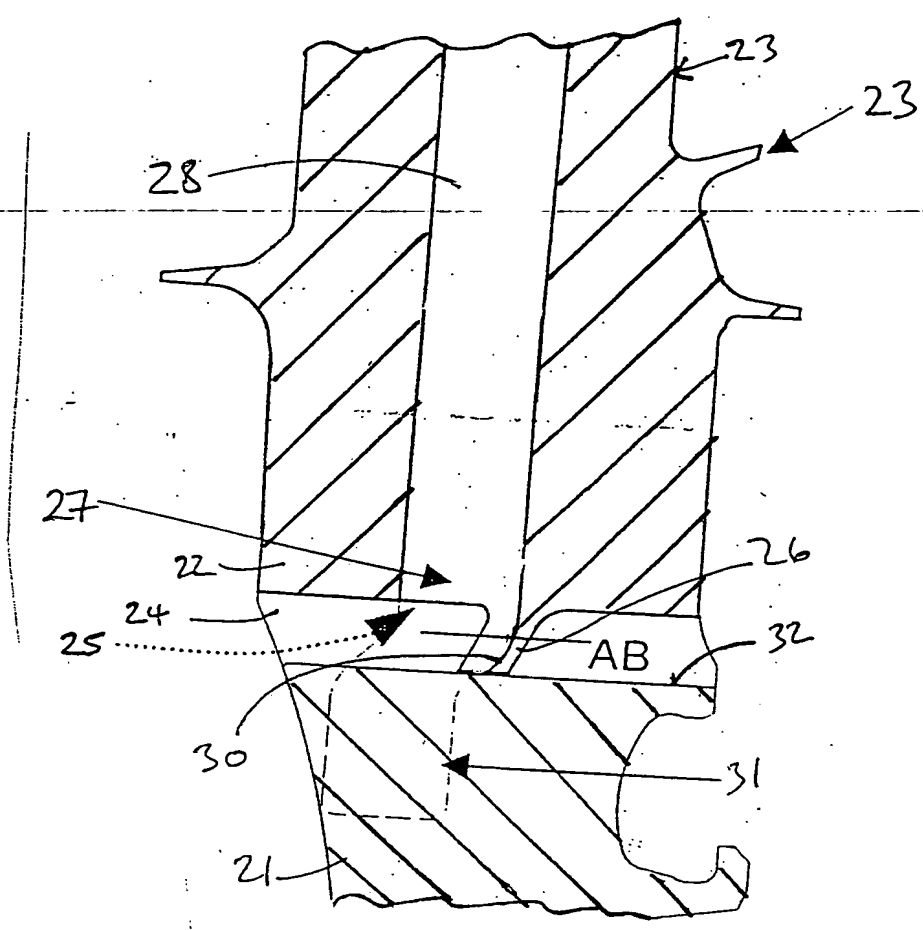


Figure 2

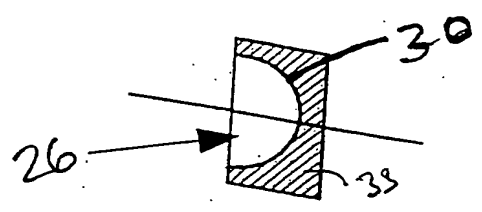


Figure 3

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